



Pultrusion at Fraunhofer

The global hub for pultrusion
research and innovation

What is pultrusion?

Pultrusion, also known as strand drawing, is a highly efficient manufacturing process for producing fiber-reinforced plastic profiles. In this process, dry fiber rovings and/or semi-finished textile reinforcements are continuously pulled through a resin bath, where the fibers are thoroughly impregnated.

The impregnated reinforcements are then drawn through a heated die, where the thermal input initiates crosslinking and curing of the matrix system, forming the composite profile. The cured profile is continuously pulled by haul-off units and then either cut to length or wound, depending on the application.

Pultrusion meets requirements of various industries

Typical pultruded profiles include hollow piping elements, profiled support structures, flat structures and much more, which are used in various applications and industries. The range of applications for pultruded components extends from automotive engineering and the construction industry to chemical plant engineering, medical technology and aviation.

PUL process advantages

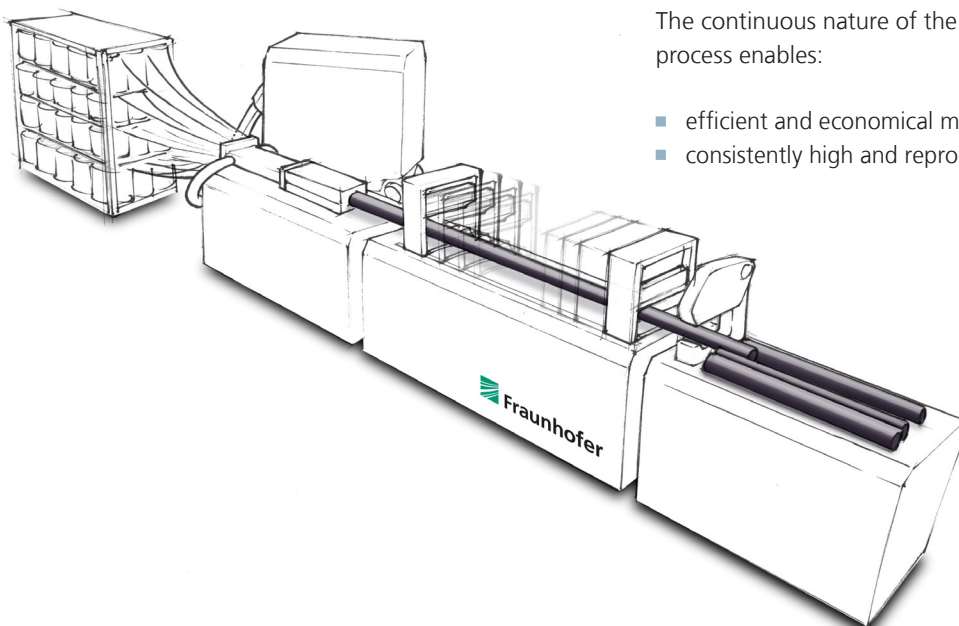
Pultrusion offers a high degree of design freedom, enabling the production of profiles with tailored properties. In particular, pultruded profiles are:

- lightweight
- high strength and stiffness
- extremely resilient
- corrosion-resistant
- dimensionally accurate

Benefits of continuous processes

The continuous nature of the pultrusion process enables:

- efficient and economical material usage
- consistently high and reproducible quality



Three institutes: One pultrusion ecosystem

Fraunhofer ICT | Fraunhofer IGCV | Fraunhofer IWU



15+ scientists and engineers

Dedicated pultrusion experts covering all disciplines and processes.



Complete process ecosystem

4 industrial pultrusion lines, plus metering, braiding, winding, extrusion, and test labs – all in the Fraunhofer network!



Full-spectrum pultrusion capabilities

From open bath to advanced processes – thermoplastics, braiding, winding, and more!



From feasibility to industrial deployment

We support the full journey – from lab trials to on-site commissioning.

Your go-to R&D partner to push the boundaries of pultrusion

Pultrusion – key technology for continuous composites

Pultrusion enables the cost-efficient production of high-performance, continuous fibre-reinforced profiles that meet stringent structural and functional requirements across a wide range of industrial applications.

As a scalable process for thermoset and thermoplastic systems, it opens up new possibilities for lightweight design, durability and recyclability in demanding applications.

World's largest pultrusion innovation ecosystem

Three Fraunhofer institutes combine their complementary expertise to form the world's largest research and innovation ecosystem for pultrusion. Together, we cover reactive matrix development, bio based and recycled composite materials, industrial scale pul-braiding and pul-winding, thermoplastic routes and advanced hybridization and forming processes.

Competence along the entire value chain

Our joint activities span the full value chain: from material formulation and fibre architecture via tool design, process simulation, digitalized process control and track and trace solutions through to comprehensive mechanical, physical and durability testing.

This integrated approach enables robust, industrially relevant solutions that significantly shorten ramp up times and increase process reliability.

Partnership for industry and society

With flexible industrial scale lines, modular machine layouts and a strong interdisciplinary team, we translate pultrusion innovations into real applications for sectors such as automotive, construction and general industry. In close cooperation with our partners, we develop tailored component and process concepts that support resource efficiency, climate protection and sustainable value creation.



*Pultrusion
in-line printer*



Fraunhofer Institute for Chemical Technology ICT

The focus of Fraunhofer ICT is on process development and the adaptation of reactive matrix systems for high-performance and economical pultrusion applications. Our portfolio includes thermoset resins as well as reactively processed PA6 and brand-new systems like Proxima™ and reactive PLA. They can be modified with additives to adjust processing behavior and component performance for both thermoplastic and thermoset resins.

Downstream and hybridization processes

We extend pultrusion into integrated component manufacturing through a broad range of downstream and hybridization technologies. We also combine our thermoplastic profiles with short and long fibre thermoplastics via LFT-D, injection molding and thermoplastic SMC to create multifunctional lightweight structures. The profiles are integrated into main load paths of structural parts across sectors such as automotive, construction and others.

Pultrusion meets
the require-
ments of various
industries

Track and Trace

Our integrated digital solutions with comprehensive data acquisition along the pultrusion line enable deep process understanding and targeted optimization. Process and quality data are linked to individual profiles, providing full track and trace and forming the basis for digital product passes with energy and CO₂ footprints. The resulting insights enable concrete recommendations for operators, improving robustness, quality and overall efficiency.

Die design and testing

We develop pultrusion dies and optimize them to your specific matrix systems, fibre types and profile geometries. With our engineering approach, we ensure robust impregnation, stable fibre guidance and efficient temperature control for simple to medium complex cross sections. Dedicated test setups and a wide range of mechanical, physical and durability tests enable systematic evaluation and a comprehensive assessment of materials, profiles and hybrid parts.

Applications

Our collaborations with partners from automotive, construction, and other sectors enable the transfer of know how in new materials and process variants into real components. We support you to shorten ramp up times, to increase process reliability and provide a scalable basis for industrial implementation.



Our equipment

- **Nanjing LYT pultrusion line**
Caterpillar puller: max. width = 300 mm, pull speed: 0.1–3.0 m/min, pull force: up to 8 t, heating with up to 6 zones and max. 240 °C
- **Low pressure dosing unit for Caprolactam (aPA6)**
Static mixing head, pre-heating up to 150 °C, mixing ratio from 100:10 to 100:100, output capacity 10–3000 g/min
- **Tartler Nodopur for PUR-dosing**
Pre-heating up to 95 °C, mixing ratio from 100:50 to 100:200, output capacity 30–300 g/min
- **Additional equipment**
 - Resin bath with housing, pressure pots, fiber drying oven
 - Various pultrusion dies and i&i chambers for flat profiles, rods, tubes and structural shapes
 - Measurement and data acquisition systems (Energy, CO₂ Eq., etc.)
 - Inline printer for Track-and-Trace

Glass fiber racks with guiding



Proxima™ pultrusion profiles

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*PulBraiding at
Fraunhofer IGCV*

Our equipment

■ Pultrex PX500 – 10T

Alternating pullers and caterpillar: max. width = 500 mm, pull speed: 0.1–4 m/min, pull force: up to 10 t, heating with up to 6 zones and max. 400 °C

■ Pultrex PX62 – 200

Alternating pullers: max. width 750 mm, pull speed: 0.1–3 m/min, pull force: up to 8 t, heating with 10 zones and max 400 °C

■ Tartler dosing units for PUR (Nodopur VS) and Epoxy (Nodopur VS AR)

Nodopur VS: Pre-heating up to 90 °C, mixing ratio from 100:100 to 100:140, output capacity 80–800 g/min;
Nodopur VS AR: Mixing ratio from 100:40–100; output capacity: 500–2000 g/min

■ Additional equipment

- Resin bath with housing, pressure pots, fiber pre-heating units
- Double ring braider Herzog RUH2/60/84-120
- Two single screw extruders
- Pultrusion dies and I&I chambers for profiles, rods, tubes, and structural shapes
- Measurement and data acquisition systems (surface quality, energy, CO₂ Eq., etc.)
- Inline printer for Track-and-Trace



Pultrusion of a "Seat-Carrier" Profile

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Fraunhofer Institute for Casting, Composite and Processing Technology IGCV

Support is provided along the entire development chain, from initial feasibility studies and profile concepts to material selection, die and injection box design, prototyping, validation and series-relevant manufacturing. The close interaction between design, materials, processing and downstream technologies enables short development cycles and reliable industrial transfer.

Complex profiles with 2D reinforcements

Pultruded profiles reinforced with 2D textiles such as mats and nonwovens are developed using advanced injection box and tooling concepts. This enables robust impregnation, stable processing and scalable manufacturing of complex profile geometries.

Industrial-scale PulBraiding and PulWinding

PulBraiding and PulWinding is performed at industrial scale, enabling multi-axial, load-path-optimized reinforcement architectures. These technologies significantly extend conventional unidirectional pultrusion and allow highly functional profile concepts that are rarely available at this scale.

Thermoplastic pultrusion routes

Thermoplastic pultrusion is implemented using melt-based impregnation and commingled yarns, enabling recyclability and the integration of subsequent forming and joining steps.

Bio-based and recycled composite materials

Activities include bio-based resin systems, natural fibre reinforcements and recycled carbon fibres, processed both as yarns and as nonwovens manufactured in-house by wet-laying. Digital solutions include a real-time process data dashboard and inline surface inspection for early defect detection and improved process transparency.

Downstream bending technology for pultrudates

The process chain is extended by a bending technology for continuous fibre-reinforced composite profiles, particularly for thermoplastic pultrudates. This enables functional 2D and 3D structures and supports hybrid concepts, including overmolding. Pultrusion technologies are applied across automotive, construction, infrastructure and other industrial sectors. A proven track record exists in transferring processes and components into series-relevant applications, including structural automotive parts developed in international collaborations.

Pulling the
state of the art
forward



Fraunhofer Institute for Machine Tools and Forming Technology IWU

With more than 10 years of experience, Fraunhofer IWU is your reliable development partner in pultrusion, offering a comprehensive and flexible range of services. We support projects starting at the coupon level for fundamental investigations on traditional pultrusion systems (UP GF, EP CF, etc.) with simple profile geometries or laboratory scale setups. At the same time, we are your partner for developing complex components and innovative materials ready for direct application.

Material development

Every application has its own unique requirements. Our broad portfolio addresses them all – from standard thermoset and highly reactive matrix systems to combinations featuring sustainable, bio based options. We also provide thermoplastic materials in granulated form for melt impregnated pultrusion, as well as in situ reactive systems such as PA6 for circular solutions. All our equipment is available as a development platform, enabling customized trials across all variants.

Functionalized
profile structures for
higher efficiency
at lower costs

Process variations

For us, pultrusion means more than manufacturing straight, constant cross section profiles. We offer advanced solutions ranging from profiles with constant curvature (curved pultrusion) to multiaxially reinforced profiles based on textile preforms, and hybrid concepts tailored to your needs. Our mission is always to elevate economic series production – supported by integrated sensor technology, either within the process or directly in the profiles.

Design and tooling development

A well designed tooling concept is fundamental to cost efficient pultrusion. Beyond developing the profiling die, we create material specific impregnation solutions such as injection boxes and precisely engineered fiber guiding systems. Using a wide array of simulation tools (e.g., filling, curing, and warpage simulations), we reduce development time while improving optimization quality. With validated experience from more than a decade, we are equipped to realize even highly complex profile structures.

Cooperations and applications

Our broad network of applications and collaborations ranges from mobility and infrastructure solutions to partnerships with specialized material developers. Together, we turn ideas into complete components. We support every project phase – conducting trials on our equipment, scaling up to pilot series maturity, and ensuring seamless knowledge transfer to our partners.

Our equipment

■ Thomas Technik pultrusion line (straight & curved pultrusion)

Alternating pullers: max. width = 600 mm, pull speed: up to 2.5 m/min, pull force up to 8 t, heating with up to 16 zones

■ Dosing units (Tartler Nodupur)

– for PUR-dosing

Pre-heating up to 95 °C, dynamic mixer, output capacity 30–520 g/min

– for Epoxy (amin)-dosing

Pre-heating up to 95 °C, dynamic mixer, output capacity 66–1150 g/min

– for Caprolactam-dosing (aPA6)

Pre-heating up to 180 °C, dynamic mixer, output capacity 30–450 g/min

■ Additional equipment

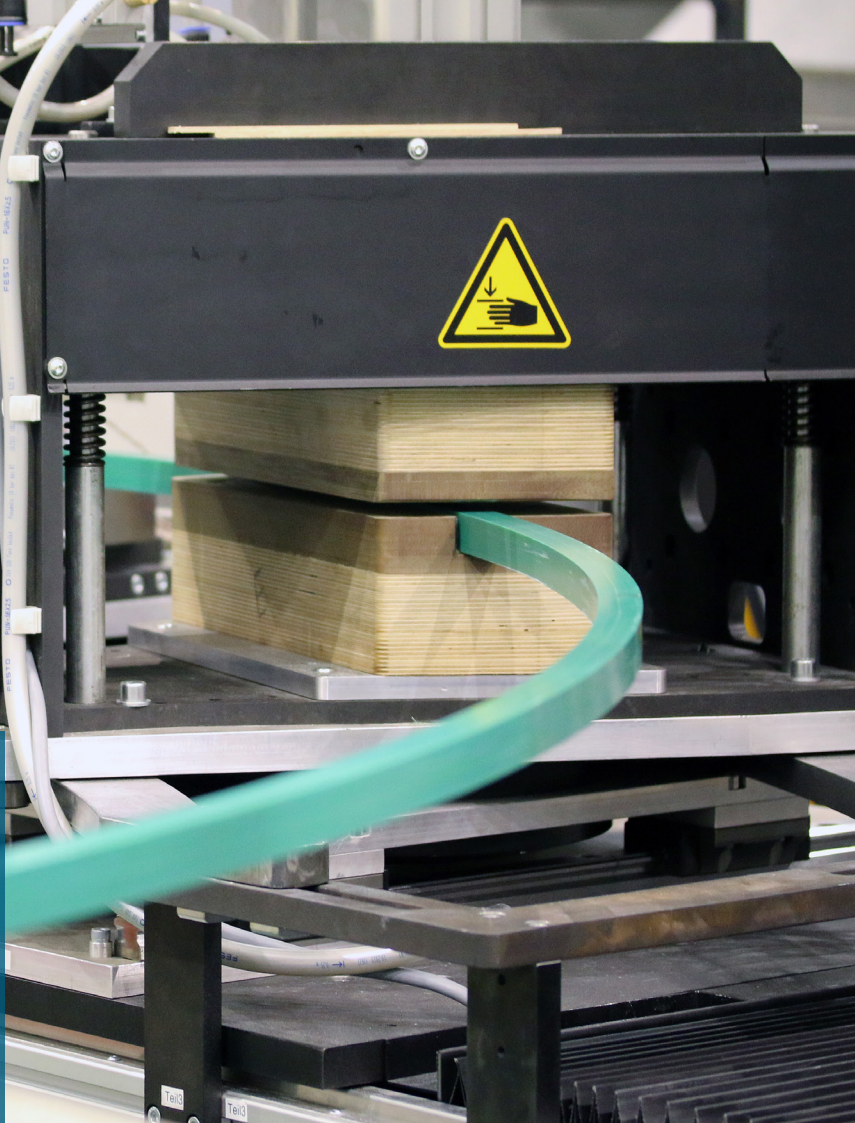
– Pre-heating resin bath with housing, pressure pots, peristaltic pumps fiber pre-heating and drying oven

– Single screw extruder

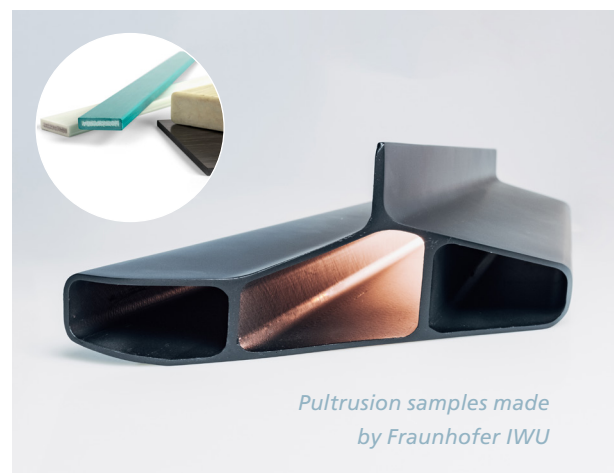
– Roll splitter for customized semi-finished textile cuts

– Various pultrusion dies and injection chambers for flat profiles, rods, tubes and structural shapes

– Measurement and data acquisition systems (surface quality, pressure, degree of cure, energy etc.)



Curved Pultrusion Process



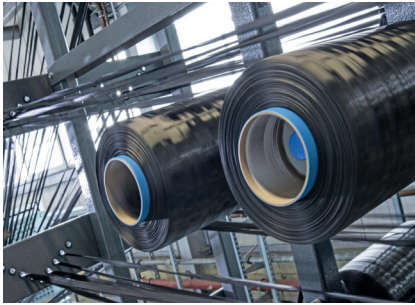
Pultrusion samples made by Fraunhofer IWU

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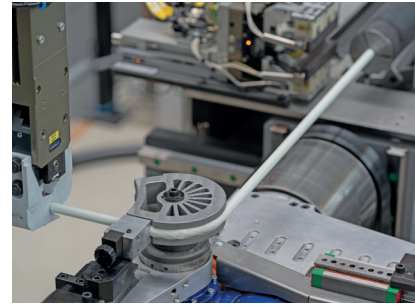
Our specialist teams provide reliable expert advice



Carbon fiber rack



Curved Pultrusion



Bending process

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